

EQUIPMENT DEVELOPMENT & TEST REPORT 5700-8

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**BELL 204B EXTERNAL
HELITANK EVALUATION**



**U.S. DEPT. of AGRICULTURE
FOREST SERVICE
EQUIPMENT DEVELOPMENT CENTER
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JUNE 1969

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EQUIPMENT DEVELOPMENT AND TEST REPORT

EVALUATION OF EXTERNAL HELITANK FOR BELL 204B HELICOPTER (ED&T 923)

U.S. Department of Agriculture, Forest Service
Equipment Development Center
San Dimas, California 91773

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ABSTRACT

Since 1963 there have been several attempts to develop a tank for installation on Bell 204B helicopters. Originally an internal tank discharging laterally out of both sides was tried.

This report describes the latest unit, an external 320-gallon tank with electrically operated doors similar to doors on fixed-wing airtankers. This tank, developed jointly by the U.S. Department of Agriculture Forest Service and the Los Angeles County Fire Department, has been the most successful.

In 1967, 72,000 gallons of water were dropped on only eight fires. As a result of FAA approval under Part 133, interested helicopter operators can now buy the tank.

INTRODUCTION

In 1963, an internally mounted tank was constructed for the Bell 204B helicopter. The tank, with a capacity of 360 U.S. gallons, was mounted in the open cabin area aft of the center row of seats and forward of the firewall. The discharge chute was mounted on the right-hand side of the tank. The chute had a trapdoor, hinged at the top, that would swing outward when released.



Figure 1
360-Gallon Drop Tank Mounted in Bell 204B Helicopter

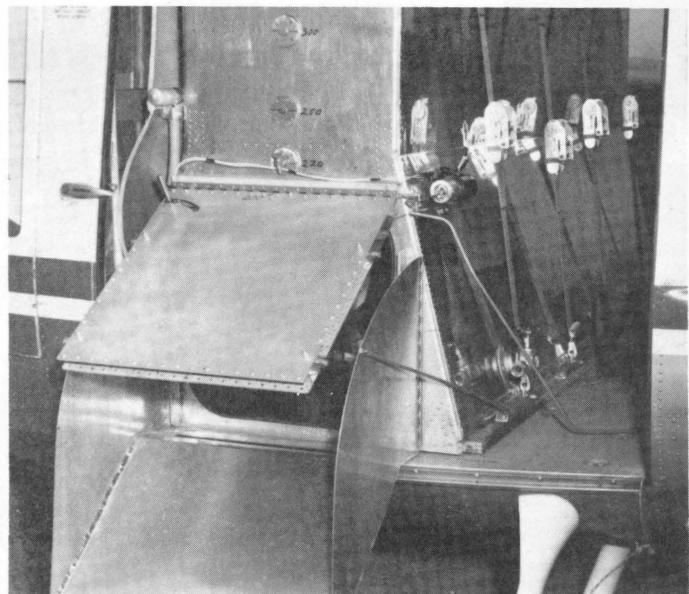


Figure 2



Figure 3. Drop Sequence

To meet FAA certification for Part 8 operation, tests were conducted to determine the inflight stability and control effects. Pattern studies were conducted to determine the pattern dimensions and shape. An observer in a T-34 chase plane took aerial photos of the patterns after each drop. The overall results of three drops are seen in Figure 4.

In 1964 the following modifications were made:

1. A vertical baffle was installed to divide the tank into two equal cells of 180 gallons each.
2. An identical discharge chute and door were installed on the left side of the tank to permit discharge from one or both sides.

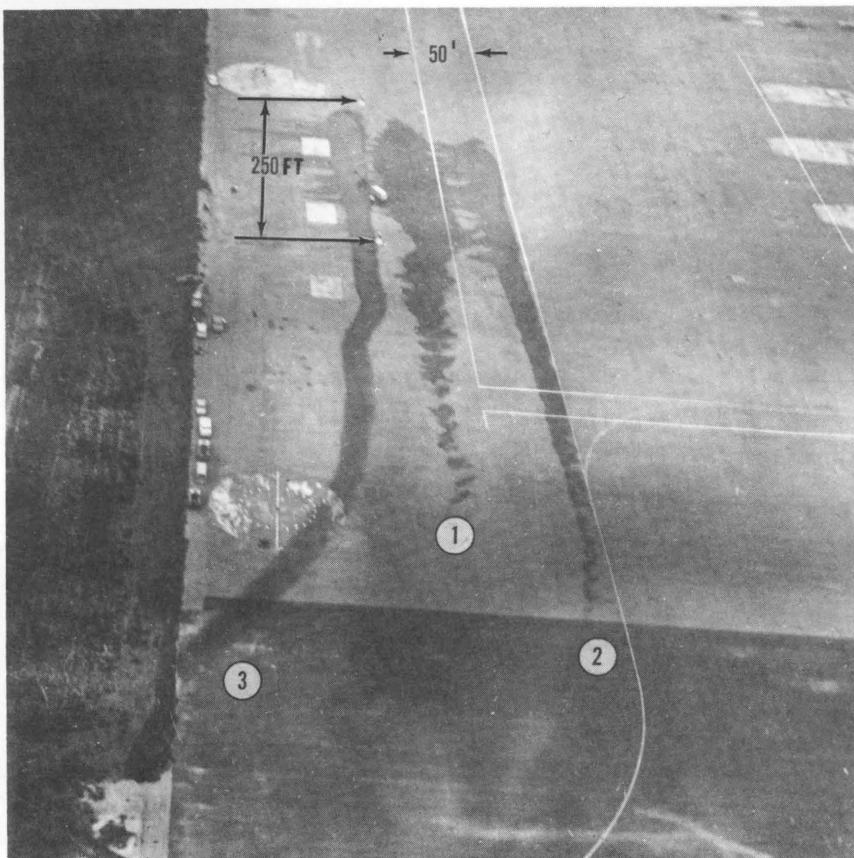


Figure 4. Results of Three Drops

Tests were conducted to study drop patterns after modification. Full-load drops disclosed a separation by a void area in the center.

When tests were concluded, it was recommended that a development project should be initiated to design and construct a quickly detachable external tank utilizing the hard points on the 204B fuselage.

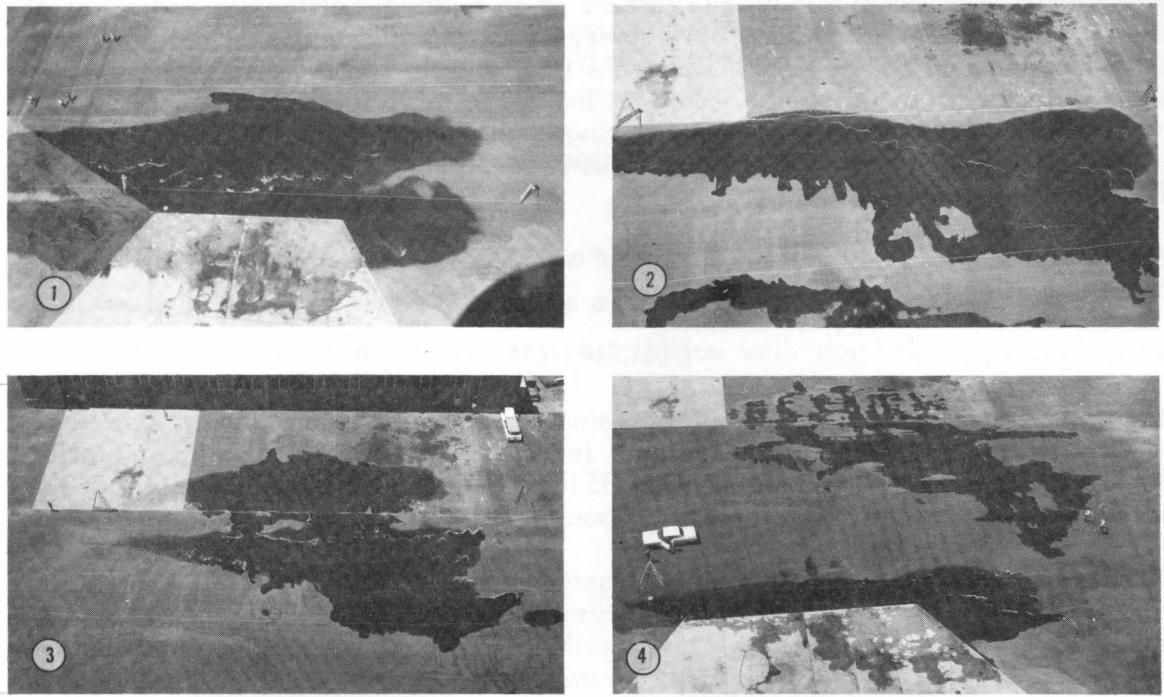


Figure 5. Aerial Views of Drop Patterns

Pattern – Aerial views of the drops are seen in Figure 5. The drops, identified in sequence, are described as follows:

DESCRIPTION	Drop Number			
	1	2	3	4
Left or both doors	Both	Left	Both	Left
Airspeed (indicated)	30 knots	20 knots	10 knots	20 knots
Actual groundspeed	38 knots	24 knots	19 knots	22 knots
Tapeline altitude	55 ft.	55 ft.	48 ft.	72 ft.
Estimated pattern length	200 ft.	200 ft.	100 ft.	100 ft.
Estimated pattern width	60 ft.	15-30 ft.	75 ft.	15-30 ft.
Void in center	10 ft.	-	10 ft.	-
Sideslip angle	0°	-	30° Left	30° Left

In March 1967 the Los Angeles County Fire Department and the Forest Service made an agreement for cooperative development of an external helitank and joint use of the Fire Department's Bell 204B helicopter. It was thought that at some later date there would be a need for a 204B helitank available to contractors. According to the agreement, the helicopter would be made available to the Forest Service, at no cost, during the development and testing of the helitank and the Forest Service would provide technical engineering assistance from the San Dimas Equipment Development Center.

The Center contracted for the building of a 400-gallon external tank and financed its construction.

DESCRIPTION

The tank was designed to be mounted externally between the fore and aft skid legs. Attach fittings were installed in the tank to utilize the two hard points at Station 80.5 and the two hard points at Station 151.5. The approximate dimensions of the tank were 93 by 71 inches. The tank capacity was 400 gallons.

Flight tests were conducted at Chino Airport on July 18, 1967, to obtain certification under CAM Part 7 when the tank is installed but empty and under CAM Part 133 when liquid is carried in the tank. After the flight tests were completed and recorded, FAA approved the tank, as requested, but limited the capacity to 350 U.S. gallons under CAM Part 133.

TESTING

Tests were conducted to determine the drop time and pattern dimensions. The discharge time was 6 to 8 seconds. It appeared that the initial 300 gallons were discharged in 4 to 5 seconds, with the remaining 100 gallons being trapped in the aft compartments and in the flat portion on either side of the doors, taking another 2 or 3 seconds to discharge and leaving a thin trail.

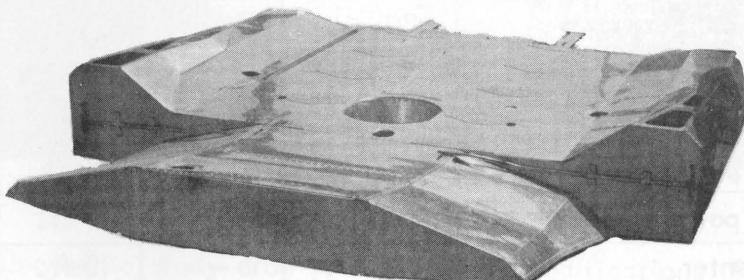


Figure 6. Before Modification

Installation of the tank was achieved by placing the tank on the heliport and flying the helicopter onto the tank. No provision was made to have the tank on the helicopter with the ground handling wheels installed on the helicopter. The tank had to be removed each time the helicopter was hangared.

Since the tests disclosed that some changes were necessary, the following modifications of the tank were made:

1. The two aft outboard compartments were removed.
2. The sides were sloped toward the doors 15 degrees.
3. Provisions were made for tank installation with the helicopter at rest and ground handling wheels installed.

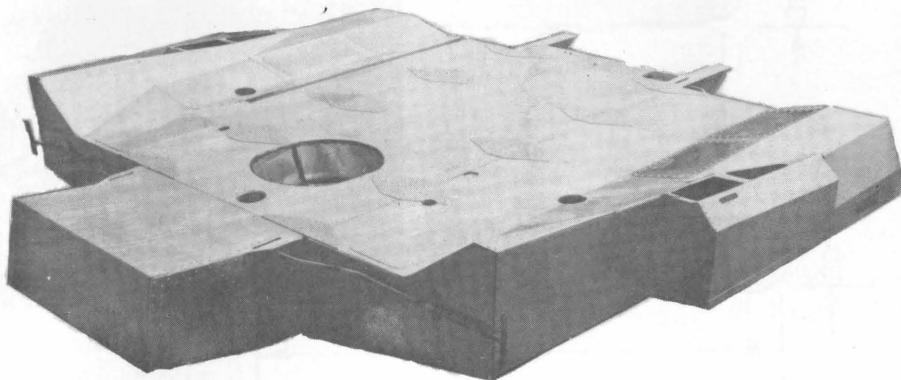


Figure 7. After Modification

When the modification of the tank was completed, weight and balance computations were found to be within limits. The new dimensions of the tank are 93 by 71 inches; the empty weight of the tank is 184 pounds; the EWCG of the tank is at Station 115.5; and the modified capacity of the tank is 320 U.S. gallons. The modified tank can be installed on the helicopter, with the ground handling wheels attached, in approximately 4 to 5 minutes.

TEST RESULTS

Drop tests were conducted at Chino Airport on October 26, 1967, to obtain pattern dimensions and shape. All drops were made from a tapeline altitude of 50 to 60 feet.

Drop No. 1 was made at 30 knots;
the pattern, 30' x 200'

Drop No. 2 was made at 40 knots;
the pattern, 30' x 270'

Drop No. 3 was made at 50 knots;
the pattern, 30' x 335'

Drop No. 4 was made at 60 knots;
the pattern, 30' x 400'

Drop patterns were quite acceptable.

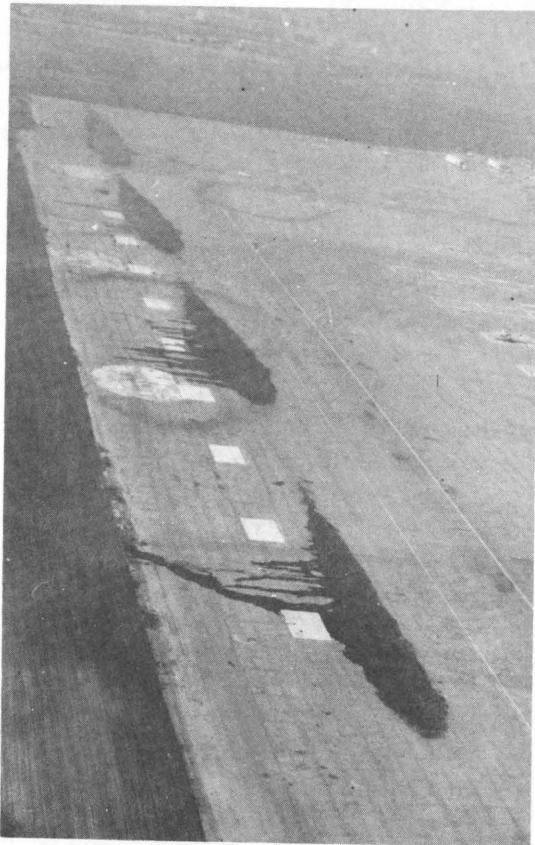


Figure 8

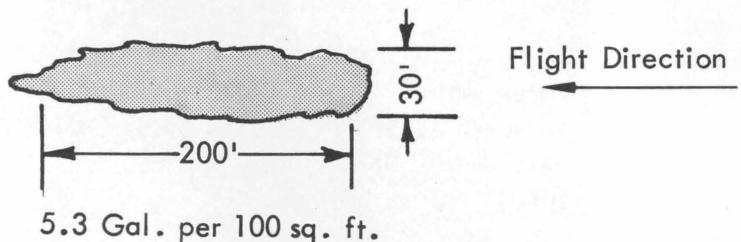
During the latter part of the 1967 fire season, drops on eight fires were made by the Los Angeles County 204B helicopter, using the modified external tank. Approximately 72,000 gallons were dropped; flying time was 10 hours.

CONCLUSIONS

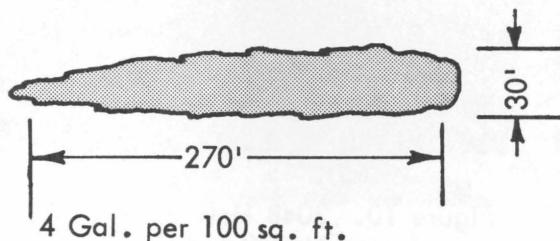
1. The modification of the 204B external tank by sloping the sides and removing the two aft outboard compartments improved the drop pattern by eliminating most of the trail that came after the initial discharge. Current patterns are within current performance criteria.
2. Installation and removal of the tank were simplified by making provision for the ground handling wheels to be attached while the tank was being installed or removed.

BELL 204B 320-GALLON TANK DROPS MADE
 AT CHINO 10-26-67
 (DISCHARGE TIME, APPROXIMATELY 4 SECONDS)
 (WIND, CALM)

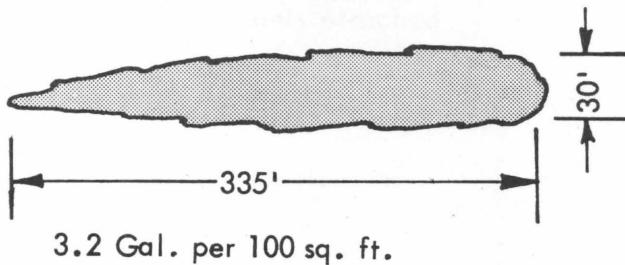
No. 1 30 knots
 34.5 mph



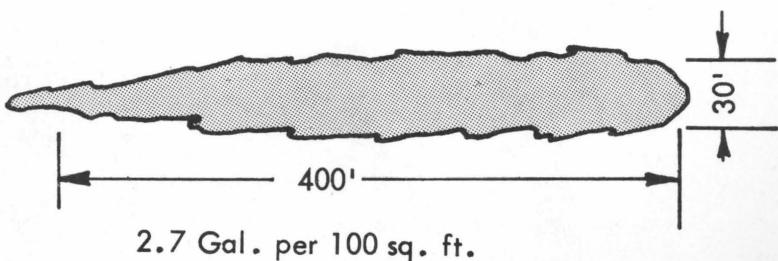
No. 2 40 knots
 46 mph



No. 3 50 knots
 57.5 mph



No. 4 60 knots
 69 mph



320 GAL. PER DROP
 DROPS MADE AT AN ALTITUDE OF
 APPROXIMATELY 50 FEET

Figure 9



Figure 10. 204B Helicopter in Flight With Modified External Tank Installed



Figure 11. Filling Tank

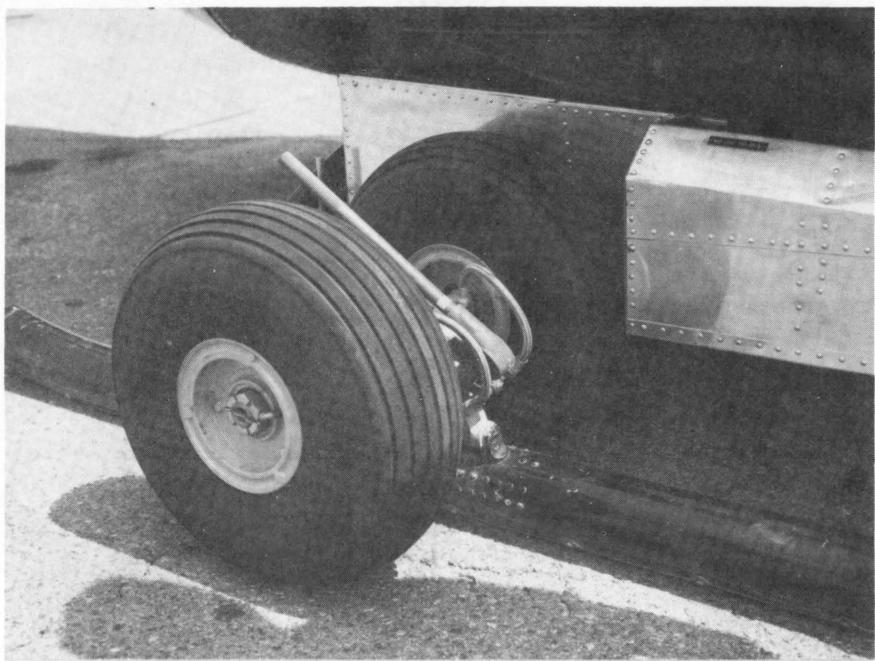


Figure 12. Tank Installed With Ground Handling Wheels Attached

RECOMMENDATIONS

1. This tank is recommended for use on fire missions as initial attack and where equivalent fixed-wing situations utilize 300- to 500-gallon drops.
2. If more tanks are built, the recess for the cargo hook could be eliminated. The cargo hook can be easily removed for tank installation. Considerable saving in the cost of manufacturing would result.

APPENDIX

WEIGHT AND BALANCE CALCULATION

FLIGHT NO. 1

STANDARD 204B SHIP NO. 2053 (N 7904 S)

DATE: July 18, 1967

SITE: Los Angeles, California

	WEIGHT	ARM	MOMENT
Basic Ship	4700.9	141.12	663,391.0
Oil	28.0	157.0	4,396.0
Fuel	875.0	136.0	119,000.0
Pilot	195.0	47.0	9,165.0
Co-Pilot	160.0	47.0	7,320.0
Flight Test Engineer	180.0	82.0	14,760.0
	6,138.9	133.3	818,232.0

FLIGHT NO. 2

MODEL: 204B With Fire Retardant Tank Installed

DATE: July 18, 1967

SITE: Los Angeles, California

	WEIGHT	ARM	MOMENT
Basic Ship	4,700.9	141.12	663,391.0
Oil	28.0	157.0	4,396.0
Fuel	450.0	136.0	61,200.0
Pilot	195.0	47.0	9,165.0
Co-Pilot	160.0	47.0	7,520.0
Fire Retardant Tank	184.0	115.5	21,252.0
	5,717.9	134.1	766,924.0
Ballast: Baggage Compartment	200.0	210.0	42,000.0
	5,917.9	137.0	808,924.0
T.O. From Heliport	- 150.0	136.0	- 20,400.0
Fuel Burn-Off, En Route Chino	- 150.0		- 20,400.0
Fuel Burn-Off, Gathering Data			
	5,617.9	136.7	768,124.0

WEIGHT AND BALANCE CALCULATION

FLIGHT NO. 3

MODEL: 204B With Fire Retardant Tank Installed

DATE: July 18, 1967

SITE: Los Angeles, California

	WEIGHT	ARM	MOMENT
Basic Ship	4,700.9	141.12	663,391.0
Oil	28.0	157.0	4,396.0
Fuel	1,400.0	136.0	190,400.0
Pilot	195.0	47.0	9,165.0
Co-Pilot	160.0	47.0	7,520.0
Fire Retardant Tank	184.0	115.5	21,252.0
Ballast: At 4-Passenger Seat	1,000.0	115.0	115,000.0
At 5-Passenger Seat	900.0	81.7	73,530.0
	8,567.9	126.6	1,084,654.0

FLIGHT NO. 4

MODEL: 204B With Fire Retardant Tank Installed

DATE: July 18, 1967

SITE: Los Angeles, California

	WEIGHT	ARM	MOMENT
Basic Ship	4,700.9	141.12	663,391.0
Oil	28.0	157.0	4,396.0
Fuel	1,100.0	136.0	149,600.0
Pilot	195.0	47.0	9,165.0
Co-Pilot	160.0	47.0	7,520.0
Fire Retardant Tank	184.0	115.5	21,252.0
Water in Tank (200 Gallons)	1,666.0	115.5	192,423.0
	8,033.9	130.4	1,047,747.0

FLIGHT NO. 5

MODEL: 204B With Fire Retardant Tank Installed

DATE: July 18, 1967

SITE: Los Angeles, California

	WEIGHT	ARM	MOMENT
Basic Ship	4,700.9	141.12	663,391.0
Oil	28.0	157.0	4,396.0
Fuel	800.0	136.0	108,800.0
Pilot	195.0	47.0	9,165.0
Co-Pilot	160.0	47.0	7,520.0
Fire Retardant Tank	184.0	115.5	21,252.0
Water in Tank (320 Gallons)	2,666.0	115.5	307,923.0
	8,733.9	128.5	1,122,447.0

FLIGHT TESTS AND RESULTS OF FLIGHT TESTS

Flight No. 1 was made to calibrate the airspeed system in the basic aircraft. Data recorded during this flight are presented in Figure 1.

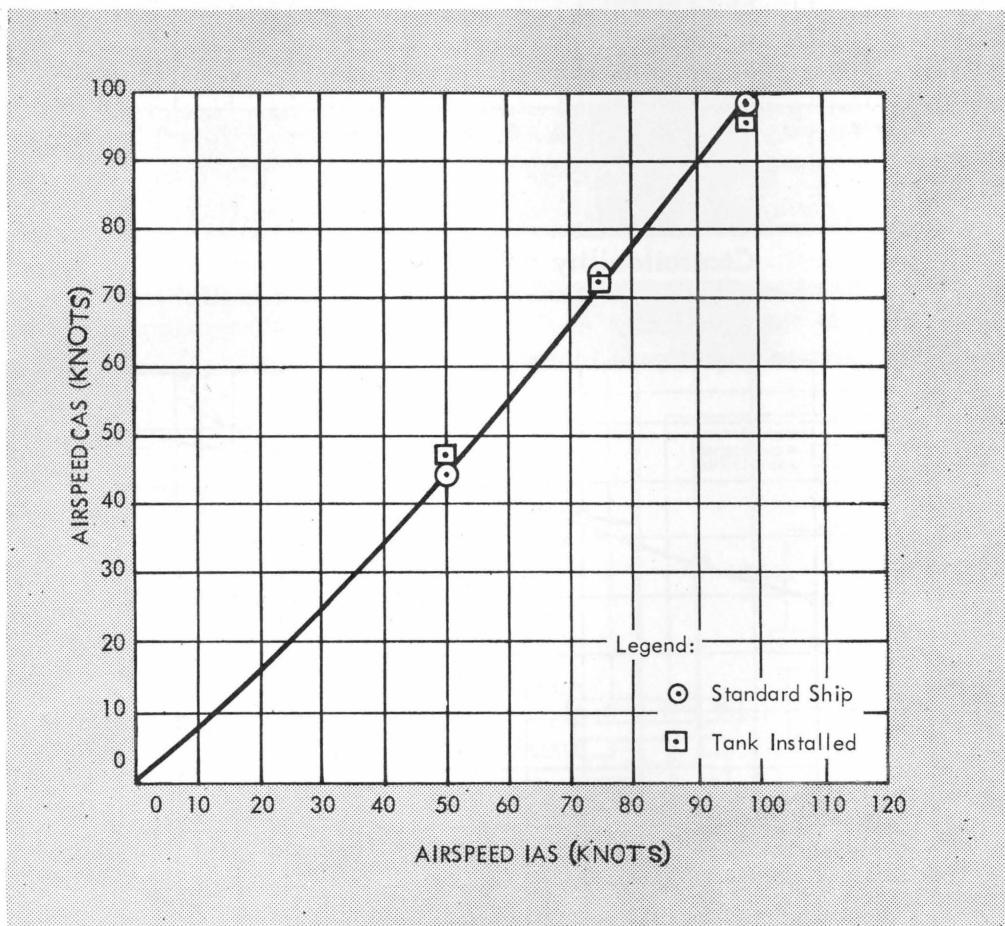
Flight No. 2 was made to calibrate the airspeed system with the fire retardant tank installed and to obtain aft CG and light gross weight controllability and stability data. The airspeed system calibration is presented in Figure 1, and the controllability and stability stick plot is presented in Figure 2. This configuration duplicates the solo pilot, no-load condition.

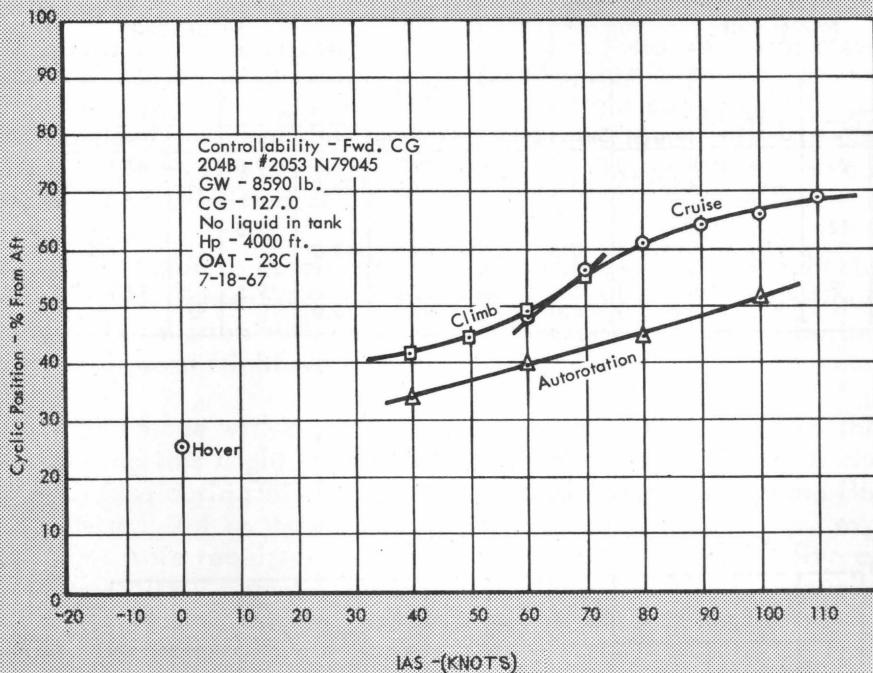
Flight No. 3 was made to obtain forward CG and heavy gross-weight controllability and stability data. These data are presented in Figure 3. This configuration duplicates the passenger mission with the fire retardant tank installed. During this flight, rearward and sideward flight were evaluated.

Flight No. 4 was made with a partial load of water (200 gallons) in the fire retardant tank. During this flight an evaluation was made as to the slosh characteristics of the liquid. Also during this flight several transitions from powered flight to auto-rotation were executed to determine if any unusual attitudes were experienced or pilot techniques were required which would compromise the validity of the Model 204B height-velocity diagram presented in the approved Flight Manual. At the conclusion of Flight No. 4, the 200 gallons of water was jettisoned at 60 knots to determine the effect on trim.

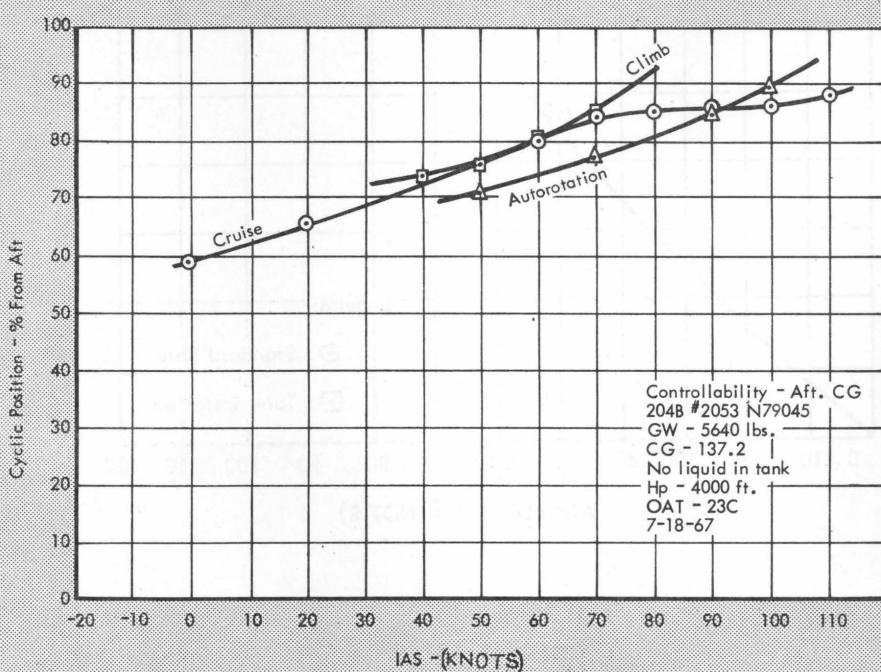
Flight No. 5 was flown with a full load of water (320 gallons) in the fire retardant tank. This configuration duplicates the firefighting mission for which certification is sought under CAM Part 133. The data recorded during this flight are presented in Figure No. 4. At the conclusion of Flight No. 5, the 400 gallons of water was jettisoned at 60 knots to investigate the effect on trim.

MODEL 204B STANDARD CONFIGURATION							MODEL 204B FIRE RETARDANT TANK INSTALLED						
Pilots A/S Indicated	Time		Velocity			System Error	Pilots A/S Indicated	Time		Velocity			System Error
	East	West	East	West	Avg.			East	West	East	West	Avg.	
49.0	21.0	20	44	46)	45)	3.75	50.0	20.0	19.5	46	47)	46.5)	3.0
48.5							49.0						
74.0	13	12	71	76)	74.5)	0.5	75.0	13.0	12.5	71	73)	72.0)	2.5
74.0							74.0						
100.0	9.5	9	97	102)	99.5)	0.0	100.0	10.0	9.5	92	97)	95.5)	2.5
99.0							96.0						

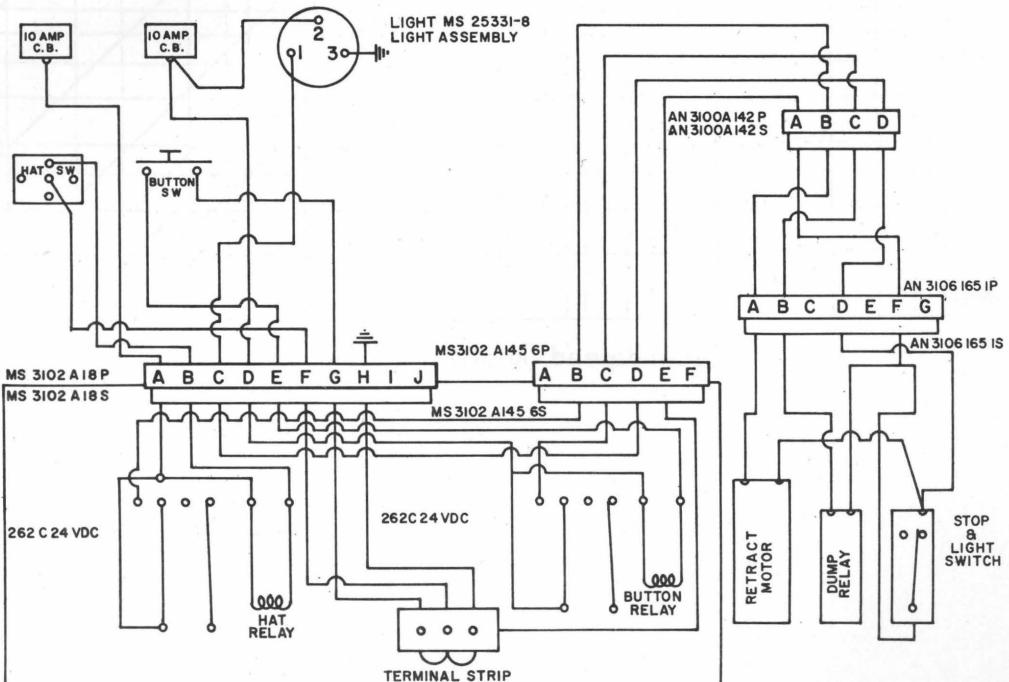
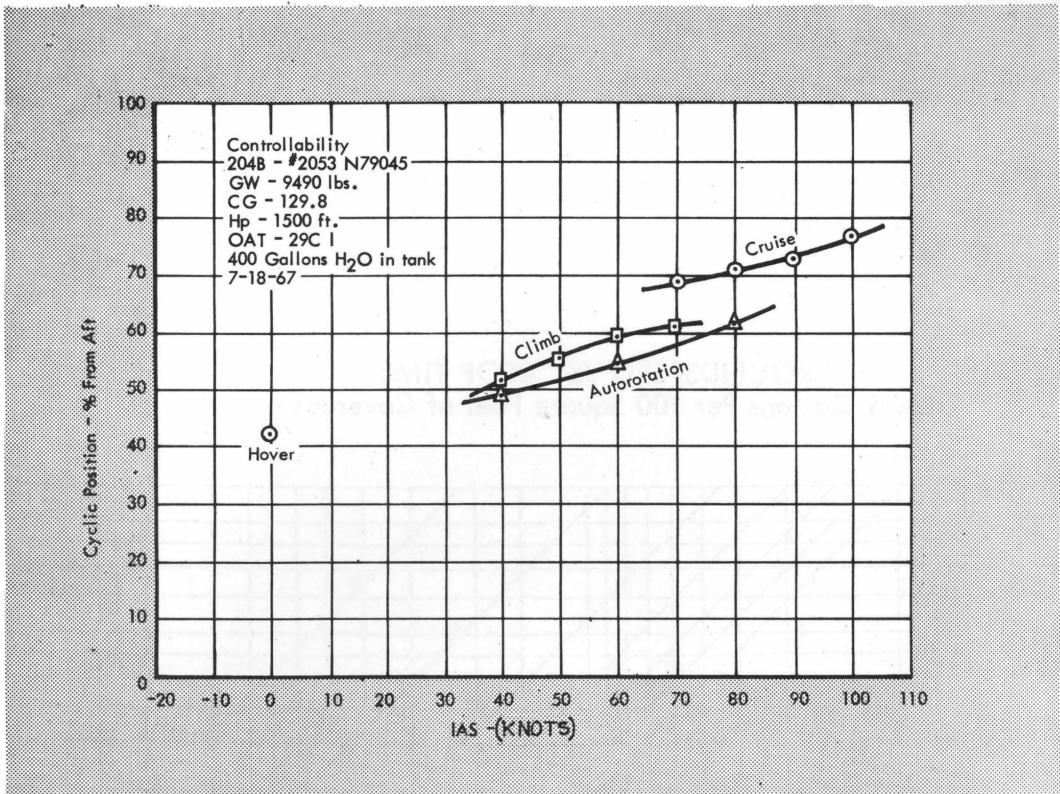




Controllability - Forward CG



Controllability - Aft CG



Electrical Circuits 204B Helicopter and Water Tank

GROUND SPEED VS. DROP TIME
(For 4 Gallons Per 100 Square Feet of Coverage)

